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Image Processing Based Leaf Rot Disease, Detection of Betel Vine (*Piper Betle*L.)

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Abstract

This paper deals with leaf rot disease detection for betel vine (*Piper betel* L.) based on image processing algorithm. The measurement of plant features is a fundamental element of plant science research and related applications. The information related to plant features is especially useful for its applications in plant growth modeling, agricultural research and on farm production. Few methods have been applied in leaf rot disease detection for betel vine leaf (*Piper Betel* L.). Traditional direct measurement methods are generally simple and reliable, but they are time consuming, laborious and cumbersome. In contrast, the proposed vision-based methods are efficient in detecting and observing the exterior disease features. In the present investigation, image processing algorithms are developed to detect leaf rot disease by identifying the color feature of the rotted leaf area. Subsequently, the rotted area was segmented and area of rotted leaf portion was deduced from the observed plant feature data. The results showed a promising performance of this automatic vision-based system in practice with easy validation. This paper describes the steps to achieve an efficient and inexpensive system acceptable to the farmers and agricultural researchers as well for studying leaf rot disease in betel vine leaf.

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1. Introduction

The betel vine (*Piper Betel* L.) has a life span of about 2-3 years¹. During their short life span they are

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offensubjected to various fungal and bacterial diseases. Such as leaf rot, leaf spot and powdery mildew. Both the quality and quantity of agriculture product degrade due to the presence of various diseases found in betel vine plants. Moreover, the disease adversely affects the mechanism such respiration, photosynthesis essential for the growth of the betel vine plant.

This highly sustainable crop is capable of generating high revenue and is of greater importance for national economy². The betel vine garden is subjected to high yield loss when it is attacked by Leaf rot³. A 30-100% leaf yield loss was reported due to leaf rot disease in betel vine⁴. Leaf rot disease caused by pathogens, *Phytophthoraparasitica* results in major constraints for cultivation of the crop⁵. Relative humidity increases the chance of the leaf rot disease⁶.

Thus, a sincere attempt is required to overcome the adverse effects of leaf rot on betel vine cultivation. The conventional method applied to overcome the leaf disease problem is basically a human vision based approach. Usually the farmer itself or a skilled person or an expert is hired to explore the disease symptoms or to find some visual cues in order to identify the disease type and severity⁷. The grid counting method can be used to improve the accuracy, but this method has a cumbersome operation process and time consuming⁸.

In these cases seeking the expert advice is very expensive and time consuming. Hence, electronic expert systems are needed. Electronic expert systems enable farmers in identifying types of diseases; making the right decision and selecting the proper treatment. The expert systems are intelligent computer programs that are capable of offering solutions or advices related to specific problems in a given domain, both in a way and at a level comparable to that of human experts in a field. One of the advantages of using Electronic expert systems is its ability to reduce the information that human users need to process, reduce personnel costs and increase throughput. Another advantage of expert system is that it performs tasks more consistently than human experts⁵.

The human vision approach suffers many drawbacks. The prime drawback is that the process is time consuming and highly labor intensive. Other than this the accuracy and precision of human vision approach is dependent on the eyesight of the person or expert hired.

Therefore, to overcome the drawbacks of conventional method there is a need for a cognitive machine vision approach. Very few recent developments were recorded in the field of leaf disease detection using machine vision approach and that too for betel vine leaf is the rarest.

Digital image analysis technology focuses on color feature of objects and can be used to recognize the edge of pests in order to identify the pests and to obtain the number of pests in pest infestation detection. The major advantage of the machine vision approach is that it is quick, perfect, and very precise as compared to human vision approach. Fast and accurate method based on the image processing algorithm is proposed in this study.

2. Materials and Methods

2.1. Study site



Fig.1. (a) Farmer showing the effect of leaf rot in the betel vine garden (b) Field acquired image of the rotten Betel leaf sample.

The experiments were carried out in Dhara, a village under Rajnandgaon district of Chhattisgarh state India, located between 21° 15' N and 80° 50' E. Fortnightly data were recorded from an established Betel vine cultivation field in local language called as Pan Boroj starting from 15 August 2015 and continued till 29 August 2015.

Deep black soil type was found in the study site. The proposed site has a subtropical climate characterized by hot summer and monsoon rainfall followed by dry and cold winter season. The normal average rainfall is 1273.4 mm. The annual temperature varies from 46.2 °C (summer) to 11°C (winter). The relative humidity varies from 87% (rainy season) to 35% (winter)⁹. A pictorial view of the above mentioned study site is shown in Fig.1. above.

Twelve Betel vine (*Piper betle* L.) leaves of the Bangla Desi variety were chosen. Selection sample was found to be infected by leaf rot diseases at different position of the leaf and of variable size and the same leaf was scanned as shown in Fig.2. and numbered a to l. For detection of leaf rot disease using image processing algorithms, using CanoScanLiDE 110 (Canon scanner), with 300 pixels per inch (ppi) resolution and 24 bit color depth. Above procedure was repeated for all the selected samples. The scanned images were stored in .jpg format in windows xp base laptop. The leaf rot portion was detected and the area of the infected leaf area was obtained using MATLAB 2010a.

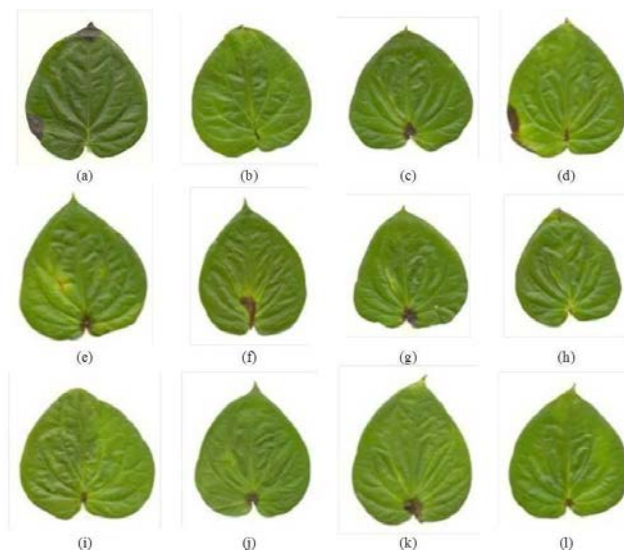


Fig.2. RGB image of rotted sample leaf

2.2. Design of proposed method

The proposed methodology has three vital stages; the initial stage was the image acquisition stage through which the real world sample is recorded in its digital form using a flat bed digital scanner. In the next stage of the research image was subjected to a preprocessing stage, making use of its size and complexity of the image was reduced. The precise digital information was subjected to segmentation process which separates the rotten portion of the leaf samples. Finally, the area of the segmented part was calculated using image processing algorithms.

2.2.1. Image acquisition

The acquired, scanned images are of 21×30 sq. cm with the selected rotted leaf sample. During a test-phase, we acquired a series of 12 color images using a flatbed scanner so as to acquire a single leaf image of betel vine leaf. The color images were digitized at a resolution of 300 dpi to produce RGB digital color images. A field acquired image is shown in Fig. 1(b).

2.2.2. Imagepreprocessing

The digital version of the rotten leaf sample consists of a about 30% of leaf area and rest 70% is the background. Thus the redundant background requires high disk storage space and utilizes CPU time in the segmentation process. In order to have efficient disk storage and achive fast processing speed the digital image of leaf sample was cropped into a smaller dimension of size 16x20sq. cm. thus the preprocessing step introduced saves about 30% of disk storage space and increases the CPU processing 1.4 times. The cropping process does not introduce any loss in the region of interest, i.e. the selected leaf sample. After preprocessing stage the digital version of the sample leaf image consist about 70% of leaf area part and rest 30% as background.

2.2.3. Segmentation

Image segmentation is the process of separating the objects present in the image. The pre processed image is now subjected to the segmentation processing stage. Very often we find a situation in which the acquired rotted leaf image at this stage, under observation is surrounded by, its petiole, stem, or neighboring leaf images and image background. The color feature of the sample image is used to distinguish rotted leaf area form healthy leaf area. The machine vision can identify a very wide range of color spectrum as compared to human vision. Color has been successfully applied to retrieve images, because it has very strong correlations with the underlying objects in an image. The color feature is robust to background complications, scaling, orientation, perspective, and size of an image. The color of the image is represented through some color model. The commonly used color models are RGB (red, green, blue), HSV (hue, saturation, value) and YCbCr (luminance and chrominance); hence for any color image the color contents are characterized by 3-channels from above color model. Each sample image is subjected to 3 channel color transformation for RGB, HVS and YCbCr, which results in 12 individual images corresponding to each color space. An example of color transforms is shown in figure corresponding to sample (e) of fig. 2.

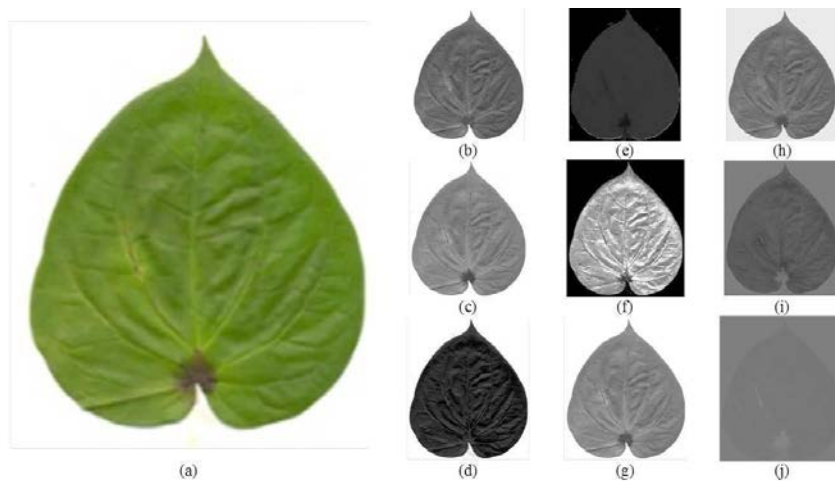


Fig.3. Original RGB image along with its components (a) Sample RGB color image (b) Red component (c) Green Component (d) Blue component (e) Hue component (f) Saturation component (g) Brightness component (h) Luminance component (i) Blue difference (j) Red difference.

By implementing the color analysis on each sample it was observed that the hue component of the HVS color model gives the clear perception of rotted leaf area. The second advantage of the hue component is that it masks the background and the rest of the leaf area. But there is a lack of separability near the edges of betel vine leaf.

Indeed, from the hue feature space shown in Fig. 3(e), it can be seen that it is necessary to use the hue based thresholding for discriminating leaf rotted part of the rest of the background. From fig. 4 the histogram plot of the hue plane, it can be observed that the rotten portion and the unaffected portion i.e. green portion of the leaf are marked separately in the hue plane. To separate the rotten portion of the leaf threshold value is chosen such that only

the rotten portion is appears in the output image. The approximate threshold value that can be applied to every betel leaf which is affected by the leaf rot disease was calculated. Fig. 4(c) shows the rotten part of the leaf after applying threshold limits. The extracted rotted leaf image contains some extra dots which need to remove off by making use of morphological operation.

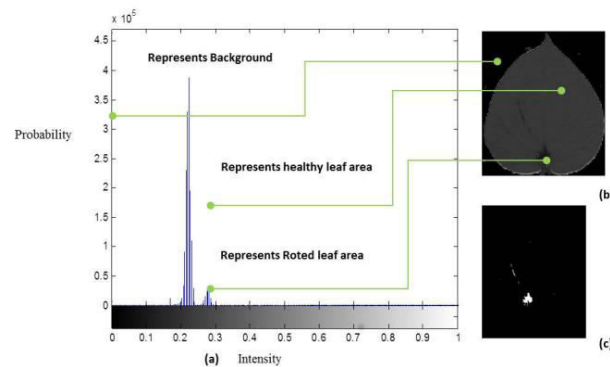


Fig.4. (a) Histogram of hue component (b) Corresponding hue component image (c) Required rotted leaf area

2.2.4. Rotten Leaf Area Calculation

To minimize the noise as shown by small white spot in fig. 5(c) these images are color transformed from the RGB image to HSV color spaces. The threshold is calculated by applying Otsu method on “H” component of HVS color space for image segmentation. Segmented binary image is consisting of the rotted area in white pixels. The number of white pixels was counted. A known calibration factor is multiplied with the number of white pixels to get the area of rotted leaf area in sq. cm.

3. Experimental Results

The following sections present and discuss some results obtained using the techniques proposed in Section 2. The rotted leaf area of all the 12 samples as shown in fig. 2 were calculated and there corresponding images are shown in figure 5.

Table. 1. Calculating the rotten leaf area

Sample	Number of pixels	Rotted area (in cm ²)
1	92908	6.6663
2	10517	0.7546
3	26564	1.9060
4	82779	5.9395
5	32084	2.3021
6	56702	4.0685
7	32289	2.3168
8	14151	1.0154
9	11027	0.7912
10	19541	1.4021
11	33929	2.4345
12	10727	0.7697

Table2. Calculating of precision and recall

Sample	Calculation for precision			Calculation for Recall		
	Correctly Detected rots	Totally detected rots	Precision	Correctly detected rots	Total rots	Recall
1	2	2	1	2	2	1
2	1	1	1	1	2	0.5
3	1	1	1	1	1	1
4	2	2	1	2	2	1
5	1	1	1	1	2	0.5
6	1	1	1	1	1	1
7	1	1	1	1	2	0.5
8	1	1	1	1	2	0.5
9	1	1	1	1	1	1
10	1	1	1	1	1	1
11	1	1	1	1	1	1
12	1	1	1	1	1	1

The number of pixels and area of rotted leaf was tabulated as shown in table 1. The standard criteria, precision, and recall¹⁰ were used to compare the performance of the proposed method. The precision and recall are defined by

equation 1 and 2;

$$\text{Precision} = (\text{Correctly detected rots}) / (\text{Totally detected rots}) \quad (1)$$

$$\text{Recall} = (\text{Correctly detected rots}) / (\text{Totally rots}) \quad (2)$$

In order to evaluate precision and recall a table consisting of correctly detected rots, totally detected rots and total rot was prepared as shown in table 2.

As it is evident from table 1. The precision of the proposed method is high, but the recall value is low in some cases it's is only 50%. The reason for low recall is possibly the threshold range used to identify dark rotted areas in the

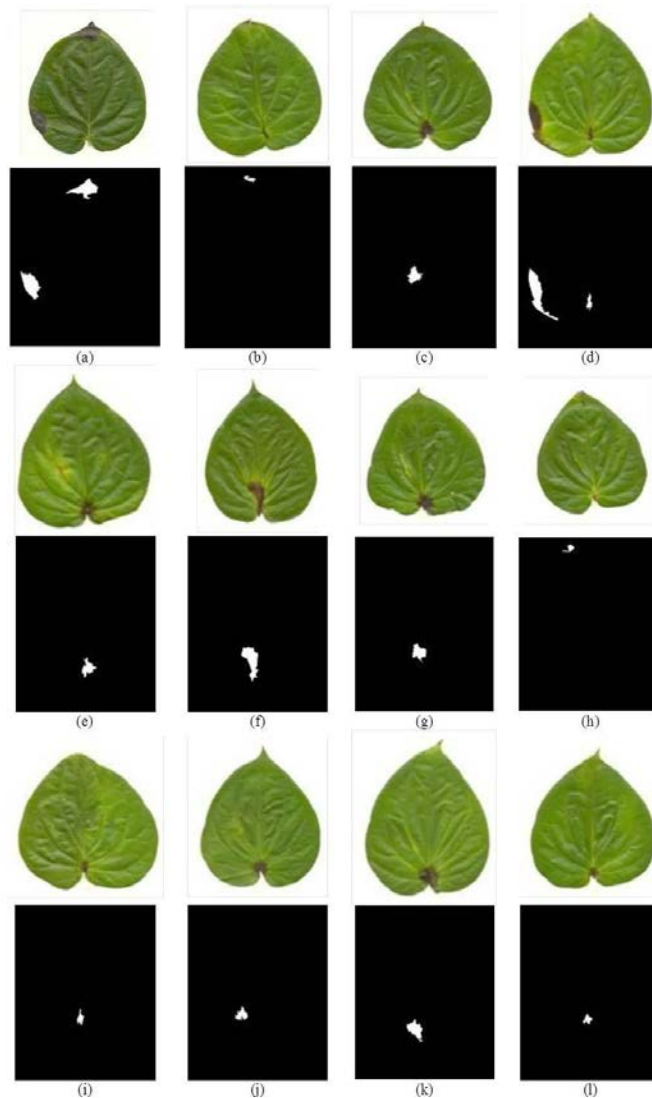


Fig.5.Segmented rotted leaf area and corresponding leaf sample in RGB color space

leaf sample and discarding the lighter area. Thus, instead of choosing a global threshold a local threshold needs to be introduced to improve the recall.

4. Conclusion

In this paper, we have implemented Otsu thresholding based image processing algorithm for segmentation of leaf rot diseases in betel vine leaf. The proposed method was successfully applied to twelve leaf image with very high precision. The proposed scheme will be helpful in the diagnosis of leaf disease. A leaf disease severity¹¹ scale can be prepared by calculating the total leaf area^{12,13} and finding the percentage diseased area. Based on the disease severity levels amount and frequency of specific quantities of pesticide application can be regulated, which reduces the cost pesticide used for treatment. Also helpful in reducing environmental pollution due to regulated and controlled application of pesticides.

This is an innovative approach ever done for extracting disease features of the leaf. The methodology uses a blend of machine vision and machine intelligence for precision agriculture. In machine vision part, image processing is used where the leaf detail, the disease infected area will be extracted. This is a small contribution towards agriculture and growing this medicinally valued precious plant species, to boost up the national economy as well as the national employment generation through proper exploitation of betel vine crop.

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References

1. Reijntjes, C., B. Haverkort, and A. Waters-Bayer. 1992. Farming for the future: An introduction to low-external input and sustainable agriculture. London: Macmillan.
2. Guha, P. 2006. Betel leaf: the neglected green gold of India. *J. Hum. Ecol.* 19(2): 87–93.
3. Chaurasia J. P. (1994). Studies on the management of Betelvine-Phytophthora disease in Sagar division. Ph. D. Thesis, Dr. H. S. Gour University, Sagar. 110pp
4. Maiti S. and C. Sen. (1979). Leaf rot and foot rot of Piper betel caused by Phytophthora palmivora. *Indian Phytopath.* 30: 438-439.
5. Goswami B. K., Kader, K. A., Rahman M. L., Islam, M. R. and Malaker, P. K. 2002. Development of leaf spot of betelvine caused by *Colletotrichum capsici*. *Bangladesh J. Plant Pathol.* 18(1&2): 39-42.
6. Kumar C. P. C. and Kumar C. S. K. (2004). Epidemiological studies on Phytophthora foot rot disease of betel vine. *Indian J. Plant Protection*. 32(2): 100-101.
7. Arivazhagan, S., Shebiah, R. N., Ananthi, S., & Varthini, S. V. (2013). Detection of unhealthy region of plant leaves and classification of plant leaf diseases using texture features. *Agricultural Engineering International: CIGR Journal*, 15(1), 211-217.
8. Patil, S. B., & Bodhe, S. K. (2011). Leaf disease severity measurement using image processing. *International Journal of Engineering and Technology*, 3(5), 297-301.
9. Central ground water board, Accessed at <http://cgwb.gov.in/nccr/Rajnandgaon.htm> on 15 December 2015.
10. Zhang, J., & Ye, L. (2009, July). Ranking method for optimizing precision/recall of content-based image retrieval. In *Ubiquitous, Autonomic and Trusted Computing, 2009. UIC-ATC'09. Symposia and Workshops on* (pp. 356-361). IEEE.
11. Patil, S. B., & Bodhe, S. K. (2011). Leaf disease severity measurement using image processing. *International Journal of Engineering and Technology*, 3(5), 297-301.
12. Soni, A.P.; Dey, A.K.; Sharma, M., (2015). An image processing technique for estimation of betel leaf area, *International Conference on Electrical, Electronics, Signals, Communication and Optimization (EESCO)*, 2015, vol., no., pp.1-5, 24-25 Jan. 2015 doi: 10.1109/EESCO.2015.7253691
13. Nayak, D.; Dey, A.K.; Sharma, M., (2015). Measurement of length and width of betel leaf by image processing using MATLAB, *International Conference on Electrical, Electronics, Signals, Communication and Optimization (EESCO)*, , vol., no., pp.1-5, 24-25 Jan. 2015 doi: 10.1109/EESCO.2015.7253754